

TABLE 3.—Maximum free-air wind velocities (m. p. s.), for different sections of the United States, based on pilot-balloon observations during July 1948

Section	Surface to 2,250 meters (m. s. l.)				Station	Between 2,500 and 5,000 meters (m. s. l.)				Station	Above 5,000 meters (m. s. l.)				Station
	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date		Maximum velocity	Direction	Altitude (m.) m. s. l.	Date		Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	
Northeast ¹	34.0	wnw.	2,460	17	Portland, Maine.....	33.7	wnw.	2,500	17	Portland, Maine.....	60.3	w.	13,850	18	Portland, Maine.
East-Central ²	20.9	ws.	1,500	29	Cincinnati, Ohio.....	26.5	w.	3,520	7	Nashville, Tenn.....	38.6	w.	11,470	26	Huntington, W. Va.
Southeast ³	21.4	wnw.	810	7	Birmingham, Ala.....	18.3	nnw.	4,960	31	Charleston, S. C.....	28.0	nne.	12,780	14	Atlanta, Ga.
North-Central ⁴	34.7	sw.	1,610	2	Duluth, Minn.....	35.2	w.	5,000	14	Alpena, Mich.....	66.0	wnw.	10,640	29	Saint Paul, Minn.
Central ⁵	28.7	sse.	2,150	29	Dodge City, Kans.....	29.2	sw.	3,820	23	North Platte, Nebr.....	44.0	wnw.	10,650	14	Des Moines, Iowa.
South-Central ⁶	24.6	ssw.	2,270	28	Houston, Tex.....	24.5	nw.	4,520	7	Texarkana, Ark.....	44.0	sw.	13,200	16	Oklahoma City, Okla.
Northwest ⁷	35.6	nw.	2,480	28	Havre, Mont.....	33.3	sw.	4,510	11	Pocatello, Idaho.....	57.6	sw.	9,610	28	Spokane, Wash.
West-Central ⁸	33.1	sw.	2,500	11	Ely, Nev.....	38.5	w.	3,330	18	Casper, Wyo.....	55.0	ssw.	10,500	1	Ely, Nev.
Southwest ⁹	24.4	ese.	1,850	13	Albuquerque, N. Mex.....	29.6	sw.	5,000	1	Las Vegas, Nev.....	49.5	ssw.	9,860	1	Las Vegas, Nev.

¹ Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania and northern Ohio.

² Delaware, Maryland, Virginia, West Virginia, Southern Ohio, Kentucky, Eastern Tennessee and North Carolina.

³ South Carolina, Georgia, Florida and Alabama.

⁴ Michigan, Wisconsin, Minnesota, North Dakota and South Dakota.

⁵ Indiana, Illinois, Iowa, Nebraska, Kansas and Missouri.

⁶ Mississippi, Arkansas, Louisiana, Oklahoma, Texas (except El Paso), and western Tennessee.

⁷ Montana, Idaho, Washington and Oregon.

⁸ Wyoming, Colorado, Utah, northern Nevada, and northern California.

⁹ Southern California, southern Nevada, Arizona, New Mexico, and extreme west Texas.

RIVER STAGES AND FLOODS

By BENNETT SWENSON

River stages during July were decidedly below normal in the central Gulf States and in the Southwest, and below normal in an area extending from Maryland northward across central and eastern Pennsylvania and eastern New York. Elsewhere, normal, or above-normal, stages prevailed. Floods occurred principally in the Carolinas, the upper Mississippi Basin, and in the Columbia River Basin, but were mostly of a minor to moderate nature.

Precipitation during the month was above normal principally in Minnesota, Iowa, Indiana, Ohio, West Virginia, the Carolinas, Florida, and coastal areas of the west Gulf States; elsewhere there were general deficiencies. The driest areas were the central and south-central Mississippi Valley, the interior of the west Gulf area, the southern Great Plains and in the lower Potomac Valley.

Hudson Bay Drainage.—Two minor floods, causing slight damage, occurred in the Red River of the North at Moorhead, Minn., both originating during June, the first with a crest of 19.2 feet on June 6, and the second with a crest of 20.4 feet on July 2. Flood stage at Moorhead is 17 feet. No flood stages were reached at Wahpeton or at Grand Forks, N. Dak., upstream and downstream stations, respectively.

The early June rise was caused by heavy rainfall in connection with a disturbance which moved from eastern Nebraska to southwestern Minnesota on June 2. The 6-hour precipitation at Fargo, N. Dak., at 7:30 p. m., June 2, was 1.53 inches, and amounts of 1 inch or more occurred over much of the upper basin. These rains followed a showery period on May 29-30.

The rise late in June resulted from similar conditions. Rains of 0.5 inch occurred at many points. These rains were also preceded by a rainy period. At Hankinson, N. Dak., 1.34 inches of rain fell in a 48-hour period and the total for 7 days ending June 28 was 4.37 inches.

Great Lakes Drainage.—Moderate floods occurred in the Grand River and Flint River Basins in Michigan during June. This is the first time in 38 years that flood stages have occurred in the Grand River in the month of June. River stages were considerably above normal at the close

of May from abnormally heavy precipitation. Heavy rains continued the first 2 days of June. Lowlands north of Grand Rapids were flooded from June 3 to 8 and the flood plains of the Grand River in Ionia and Kent Counties were inundated for several days, causing a loss to prospective crops estimated at about \$1,000,000 in Ionia County.

Heavy rains on July 6-7 and 16-17, over the headwaters of the Maumee River Basin resulted in some flooding of lowlands. Flood stages were exceeded in the St. Joseph River at Montpelier, Ohio, on July 9, and in the St. Marys River at Decatur, Ind., July 17-18.

Flooding occurred in the vicinity of Toledo, Ohio, on July 6, when easterly winds causing high waves and tides in Lake Erie served to form breaks in an earthen dike along the Lake.

Atlantic Slope Drainage.—Precipitation was heavy during the month in the Carolinas and light to moderate overflows occurred principally in portions of the Roanoke, Neuse, Cape Fear, Pee Dee, Santee, and Savannah River watersheds. There were several periods during the first half of July when rainfall was heavy, mostly in the form of showers.

Upper Mississippi Basin.—High water and considerable flooding in the upper Mississippi Basin in June continued into July with a number of additional rises occurring in July. Reports of the floods are submitted by the officials in charge of the river district offices as follows (a report by the Minneapolis office was published in the June issue of the REVIEW):

LA CROSSE, WIS.

Widespread rains of the frontal thunderstorm type were responsible for three distinct flood periods in June; the first period beginning with a moderate flood in the Chippewa River on June 1 and culminating with flood conditions in the main channel of the Mississippi on June 7; the second beginning with floods in the Chippewa and extreme upper reaches of the Mississippi on June 16, producing floods in the main channel from Reads, Minn., to Genoa, Wis., by June 22; and the third a flood of severe proportions in the Chippewa and extreme upper Black Rivers, beginning on June 27, which produced a secondary rise in the section from Reads to Genoa by July 2. Each succeeding flood took place on a fairly well developed recession from the former one. The flood occurring on the Chippewa at the end of June was most severe, and due to the fact that it was not supported by full flood volume from above Lake Pepin, considerable was lost in storage in that lake by flowing northward. This resulted in the flood stages from Reads to La

Crosse slightly under those occurring around June 22. A severe flood developed in the extreme upper Black River on June 27 and 28 with near all time record flow at Neillsville, Wis. Some flooding took place on the Cannon River on June 12 and somewhat less than bankful on the Zumbro River on the same date.

The floods were unusual in that one flood followed another in the main channel, just as recession from the former one had developed. This resulted in an exceptionally large volume flow with high mean stages for the month. In June 1880, when the extreme maximum stage of 16.2 feet was recorded at La Crosse, the mean stage was 11.7 compared to 11.6 in June 1943 when the crest stage was 13.3 feet. This record was brought about by the three major floods on the Chippewa and two on the Black River.

Flooding in the main channel of the upper Mississippi during July was the result of the third series of flood producing rains which fell from the 27th to the 30th of June. The Mississippi was above flood stage at La Crosse from July 1 to 6, cresting at 12.8 feet on the 3d; at Winona, Minn., from July 1 to 4, cresting at 14.0 feet on the 3d; and flood level was just reached at Reads, Minn., on July 1.

Thunderstorms the night of July 5-6 with excessive rainfall were general along the main channel of the river in this district and especially in drainage area of the Root, Zumbro, and Whitewater Rivers. In general, the rains were of short duration, but fell at a time when the soil was fairly well saturated. The volume of runoff was therefore considerably above average conditions. The Root River crested at 11.6 at 4 p. m. of the 6th, which is about 3 feet under bankful, so no particular damage resulted in this valley. The Zumbro at Theilman, Minn., crested at 38.6 at 4 p. m. of the 6th, or 2.6 feet above flood stage. Cornfields and gardens were flooded in the bottom lands resulting in considerable damage. The Whitewater at Beaver, Minn., crested at 5.9 feet (low-water elevation; flood stage 7 feet), about the same time. Agricultural losses here were not so pronounced.

DUBUQUE, IOWA

Two distinct floods occurred in the Wisconsin and Mississippi Rivers during June-July. The primary cause was widespread rainfall in heavy amounts and in considerable frequency. In some instances the rains were sufficiently restricted geographically so that some of the communities on the Wisconsin, which are especially susceptible to flood damage, were fortunate enough to escape losses.

The second flood set in upon a recession of the earlier one, and this fact was especially noteworthy in the Mississippi where warnings of the second rise were issued almost immediately after the first crest reached the lower limits of the district.

In the Wisconsin River floods, the general aspects were not especially different from the usual characteristics of the almost annual flood occurrences. In the Mississippi, however, the outstanding feature was the long persistence of high water. At Dubuque, the July flood produced the third occurrence of a flood stage during the year. This was the first record of three floods at Dubuque in any one calendar year, and the first occurrence of a flood in July.

Losses due to flooding were heavier than in recent years in crops and prospective crops, largely because the early season flood delayed planting, and the subsequent floods destroyed those crops which were well started, and so covered the lowland fields with rubbish and silt that replantings were difficult, if possible. Another crop damaging factor was the long persistence of the high water, to so late a time that replantings were impracticable.

DAVENPORT, IOWA

Two periods of relatively high water on the Mississippi River in the Davenport river district in June were the result of heavy rains in the upper Mississippi Basin, especially in Wisconsin and Minnesota. The first period extended from June 13-18, and the second from June 29 into the first half of July.

The floods were somewhat similar to the rise which occurred in April 1943. Tributary contribution to the flood waters in June were slightly less than in the April rise. This feature resulted in lower stages as the crest moved downstream than occurred during the April rise.

A local flood at Iowa City, Iowa, on the Iowa River occurred on June 2. It was not possible to issue warnings because of the suddenness and excessive nature of the precipitation causing it. The highest stage reported was 11.1 feet at about noon of June 2.

BURLINGTON, IOWA

From June 6, through June 30, moderate to severe flood conditions occurred on the Mississippi River from Keokuk, Iowa, to dam No. 24. High water from up-river began to enter the district on June 2 and this rise plus additional heavy rainfall in and above the district during the first half of the month caused rising stages almost continuously until June 18. A falling tendency set in on June 19 and continued until June 26 when a second rise from up-river entered the district. This rise was still in progress at the close of the month with all stages from Keokuk, Iowa, to Louisiana, Mo., above flood.

Heavy rainfall in northeast Missouri on June 9 and 10 caused the Salt River near New London, Mo., to exceed flood stage on June 11 and 12, with a crest of 21.3 feet on the 11th (flood stage 19 feet).

Flood conditions which prevailed from Keokuk, Iowa, to Louisiana, Mo., at the end of June continued past the middle of July due to locally heavy rains in and above the district from July 1 to 6.

Although this was one of the longest flood periods of record for this district, property and crop damage was relatively small. This was probably due to the fact that much of the fall wheat had been winter killed in some sections and also that considerable acreage had not been planted because of flood conditions earlier in the season.

CAIRO, ILL.

The flood in the Mississippi during June and July affected only a relatively small area in the vicinity of Cape Girardeau, Mo.; it may reasonably be considered a continuation of the flood of May-June which reached heights that have been exceeded only in 1844. Attaining a crest of 42.4 feet on May 27 the Mississippi River at Cape Girardeau declined to a stage of 30.3 feet on June 7, only 1.7 feet below flood stage, then, due to a series of heavy rains along the Missouri River and its tributaries and on the upper Mississippi a further rise developed, continuing until June 29 when a crest of 36.7 feet was recorded.

Flood stage at Cape Girardeau was passed on the morning of June 9. Later a rapid rise occurred in the Missouri River at Kansas City, resulting in a high flood there, and with additional frequent rains falling the river at Cape Girardeau rose steadily. However, such a large amount of water flowed from the main river through breaks which had been made in levees by the May flood that the time of the arrival of the crest at Cape Girardeau was greatly delayed and the ultimate stage was increased somewhat. It is interesting to note that, while the total rise at St. Louis was approximately 12.3 feet, at Cape Girardeau it was only about 6.4 feet; a part of this discrepancy can be accounted for by the fact that, in effect the river divided into two streams above Cape Girardeau when part of the water went into the storage basin, flooded the farm land inundated in May, and much of it did not return to the main river until after the crest had passed. A fall then began and the river passed below flood stage on July 4. It is remarkable that, despite the high stage at Cape Girardeau, the Ohio at Cairo and the Mississippi at New Madrid fell every day in June except on the 30th.

Ordinarily a flood of this proportion would have caused much damage on farms; however, the previous high water had totally destroyed crops and nothing of that nature remained to be damaged. The flood of June-July 1942, which reached a crest on July 2 of 36.9 feet (almost the identical stage during this flood), caused great crop damage in much of the area under consideration.

Missouri Basin.—A slight overflow in the Floyd River at James, Iowa, resulted from moderately heavy rains during the first week in July. The river crested at 15.0 feet on July 8, 1.0 foot above flood stage. No damage resulted.

The heavy rainfall extended over eastern Nebraska and northern Missouri and produced near flood conditions in the Platte River, and a slight overflow in the Grand River at Brunswick, Mo. The rise in the Platte River raised the stage in the Missouri with light flooding resulting at Nebraska City, Nebr., on July 5-7.

Ohio Basin.—A flash flood occurred in the vicinity of Steubenville, Ohio, on July 7, with a maximum rainfall of 6.81 inches recorded. The storm was very local and confined to the small tributary streams in that vicinity.

Damage has been estimated at more than \$1,400,000 and two lives were lost.

Local flooding also occurred in northern Ohio areas from excessive rains on July 5.

A second flash flood occurred in the Pittsburgh area on July 27. The maximum official rainfall recorded was 3.9 inches at Mount Lebanon and 4.56 inches at Claysville, Pa. This storm was also of a local nature and affected sections in Pittsburgh and in the vicinity of Claysville, Pa., and Wheeling, W. Va. The damage from this storm along the small streams has been estimated at \$1,000,000.

Heavy rainfall on July 28-29 in the Tygart River and Little Kanawha River Basins resulted in moderate overflows at Dailey and Hall, W. Va., on July 30-31 in the Tygart Basin and severe flooding in the headwaters of the Little Kanawha Basin, especially in the Little Kanawha River and Salt Lick Creek at Burnsville, W. Va., and in Tanners Creek at Spencer, W. Va. The overflows at these points are said to have been the worst in many years.

Pacific Slope Drainage.—The following report of the annual rise of the Columbia River during 1943 is submitted by the official in charge, Weather Bureau Office, Portland, Oreg.:

At the close of March 1943 mountain snow storage in the area drained by the Columbia River was generally much above normal. The excess was most pronounced in the upper portion of the Snake River Basin.

A careful study of climatological data, and of snow survey reports furnished by the United States Soil Conservation Service, led to the conclusion that, with normal conditions prevailing during the melting season, the Columbia River at Vancouver would reach a crest of 25 feet, and backwater in the Portland Harbor a crest of 24 feet. This forecast was released on April 16.

That this estimate was well founded is shown by the fact that more water passed the Celilo, Oreg., gage, the lowest recording gage on the Columbia River, in the period April 1 to June 30, inclusive, than in the corresponding period in 1928, when the crest was 24.4 at Portland and 25.4 at Vancouver, or in 1933, when the crest was 24.8 at Portland and 25.5 at Vancouver.

Because weather during the melting period was not normal, the crest fell far short of the early estimate; the highest at Portland was 19.8, and at Vancouver, 19.9. April was unusually warm throughout the Columbia River Basin. In Idaho it was the warmest since the phenomenally warm April of 1934.

The abnormal warmth caused an unusually early rise in the Columbia and its tributaries, from April 1 to 23. The Snake River reached 16.0 at Lewiston, Idaho, on April 20 and 21 and 12.8 at Weiser on April 21. At both places this was the highest reading for the season. At Lewiston it was the highest April reading since 1904 and at Weiser the highest April reading of record. At many stations in the Columbia Basin and at Portland, on the Willamette, the average stage for the month was the highest April average of record, and at others it was the highest for many years. At Portland the high April average was largely due to backwater from the Columbia, but not altogether so, for a Willamette flood reached its crest at Portland on April 3.

During the latter part of April and the first 3 weeks in May the river stages receded. The Columbia at Vancouver fell temporarily below the flood stage of 15 feet on May 6.

May and June were unusually cool except for short periods. In Oregon, May was less than 1 degree warmer than April, and June had the same mean temperature as the coldest June previously of record. In Washington, the mean temperature for June was the lowest since 1917, and in Idaho, the lowest since 1908.

A moderate warm spell late in May caused a substantial rise. The Columbia at Vancouver again reached the flood stage of 15 feet on May 29, and did not fall below that stage until July 17. Backwater from the Columbia again brought the Willamette at Portland to the flood stage of 18 feet, on the afternoon of June 1. Cooler weather in the mountains brought it below flood stage on the 8th, but it again rose above flood stage on the evening of the 20th, continuing above flood stage until July 7.

Because the rises were slow and ample warning was given, very little movable property was lost. Every Columbia River flood causes some loss of crops and pasture on undiked low lands; this is considered one of the normal risks. Rental of auxiliary pasture, and moving property from flood danger, particularly heavy goods

from the lower levels of docks, entails large expense. Other losses were largely intangible. Incomplete statistics at hand indicate a loss of about \$200,000 due to the flood.

FLOOD-STAGE REPORT FOR JULY 1943

[All dates in July unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
HUDSON BAY DRAINAGE					
Red of North: Moorhead, Minn.	17	{ June 4 June 29	June 9 6	19.2 20.4	June 6 2
ST. LAWRENCE DRAINAGE					
<i>Lake Erie</i>					
St. Marys: Decatur, Ind.	13	17	18	16.0	17
St. Joseph: Montpelier, Ohio.	10	9	9	10.1	9
ATLANTIC SLOPE DRAINAGE					
James: Columbia, Va.	10	11	11	10.1	11
Roanoke:					
Weldon, N. C.	31	13	13	31.1	13
Williamston, N. C.	10	15	21	10.6	18-19
Neuse:					
Smithfield, N. C.	13	15	15	13.0	15
Goldsboro, N. C.	14	{ 13 16	14 19	14.2 14.9	14 17-18
Haw: Moncure, N. C.	20	14	14	20.5	14
Cape Fear:					
Fayetteville, N. C.	35	14	15	37.6	15
Lock No. 2, Elizabethtown, N. C.	20	11	18	28.7	15
Pee Dee:					
Mars Bluff Bridge, S. C.	17	10	21	19.8	15-17
Poston, S. C.	18	15	23	19.8	17-18
Saluda:					
Pelzer, S. C.	6	{ 2 11	4 11	6.7 6.0	3 11
Chappells, S. C.	13	1	2	15.1	2
Broad: Blairs, S. C.	14	10	11	16.8	11
Catawba:					
Catawba, N. C.	8	10	10	9.1	10
Catawba, S. C.	11	10	10	16.5	10
Savannah:					
Burtens Ferry, Ga.	15	{ 7 15	10 18	15.7 15.0	8 15-18
Clyo, Ga.	11	9	28	13.9	13
MISSISSIPPI SYSTEM					
<i>Upper Mississippi Basin</i>					
Chippewa: Durand, Wis.	11	(¹)	2	14.3	June 30
Zumbro: Thellman, Minn.	36	6	6	38.6	6
Wisconsin: Portage, Wis.	17	2	2	17.5	2
Mississippi:					
Reads, Minn.	12	1	1	12.0	1
Winona, Minn.	13	1	5	14.0	3
La Crosse, Wis.	12	1	6	12.8	2-3
Dubuque, Iowa.	18	6	10	18.7	8
Clinton, Iowa.	16	(¹)	13	17.1	June 30-1
Muscatine, Iowa.	15	(¹)	14	16.0	1-2, 11
Keithsburg, Ill.	12	{ (¹) 9	5 14	12.4 12.3	2-3 11-12
Keokuk, Iowa.	12	(¹)	17	13.95	5
Gregory Landing, Mo.	12	(¹)	18	14.2	5-6
Quincy, Ill.	14	(¹)	18	16.6	5-6
Hannibal, Mo.	13	(¹)	20	16.8	6
Louisiana, Mo.	12	(¹)	20	14.9	7
<i>Missouri Basin</i>					
Floyd: James, Iowa.	14	8	8	15.0	8
Grand: Brunswick, Mo.	12	5	12	12.6	9-10
Missouri: Nebraska City, Nebr.	15	5	7	15.5	6
<i>Ohio Basin</i>					
Buckhannon: Hall, W. Va.	10	30	31	10.2	30
Tygart, Dalley, W. Va.	9	30	31	12.7	30
<i>Arkansas Basin</i>					
Little Arkansas: Sedgwick, Kans.	18	19	19	18.3	19
<i>Lower Mississippi Basin</i>					
St. Francis: St. Francis, Ark.	18	(¹)	3	19.8	May 31
PACIFIC SLOPE DRAINAGE					
<i>Columbia Basin</i>					
Willamette: Portland, Oreg.	18	(¹)	7	{ 19.8 18.3	June 24 June 30-4
Columbia:					
The Dalles, Oreg.	40	(¹)	17	42.7	June 30-1,3
Vancouver, Wash.	15	(¹)	17	{ 19.9 18.5	June 23-24 2-3

¹ Continued from June.

² Highest observed.

³ Continued from May.